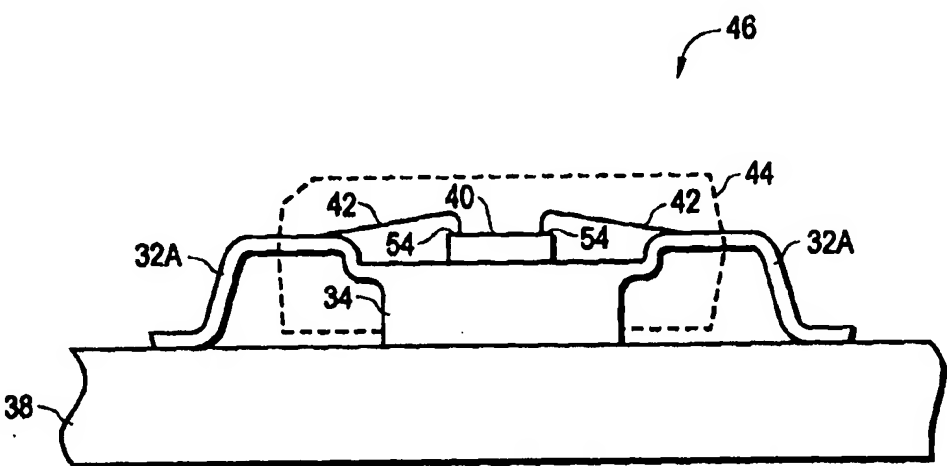


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International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US97/19309 <b>(22) International Filing Date:</b> 3 November 1997 (03.11.97) <b>(30) Priority Data:</b> 08/746,064 6 November 1996 (06.11.96) US <b>(71) Applicant:</b> SILICONIX INCORPORATED [US/US]; 2201 Laurelwood Road, Santa Clara, CA 95054-0951 (US). <b>(72) Inventors:</b> KASEM, Mohammed; 2321 Regina Court, Santa Clara, CA 95054 (US). SHINE, Carl; 11592 Bridge Park Court, Cupertino, CA 95014 (US). <b>(74) Agents:</b> HEID, David, W. et al.; Skjerven, Morrill, MacPherson, Franklin & Friel LLP, Suite 700, 25 Metro Drive, San Jose, CA 95110 (US).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i>
<b>(54) Title:</b> HEAT SINK-LEAD FRAME STRUCTURE    <b>(57) Abstract</b>  A surface mount package includes a unitary combination heat sink and lead frame, the heat sink (34) having mounted thereon a semiconductor die (40) and being mounted to a printed circuit board (38). The heat sink (34) and certain leads (32a) of the lead frame provide heat conduction paths from the die (40) to the printed circuit board (38), for highly efficient dissipation of heat.		

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## HEAT SINK-LEAD FRAME STRUCTURE

### FIELD OF THE INVENTION

This invention relates to a unitary design of heat  
5 sink and lead frame structure for semiconductor  
applications.

### BACKGROUND OF THE INVENTION

A typical dual inline surface mount package 10 is  
10 shown in Fig. 1. Such a device 10 includes a heat sink  
12 which may, for example, be of copper, and a  
semiconductor die 14 mounted thereon. Leads 16 are  
connected to the die 14 by means of conducting wires  
18, and the die 14, conducting wires 18, and inner ends  
15 of the leads 16 are encapsulated in packaging material  
20 as is well known. The extended ends of the leads 16  
are soldered to appropriate parts of a printed circuit  
board 22. It will be seen that a direct heat  
conduction path is provided from the die 14 inside the  
20 package 20 through the heat sink 12 to the board 22.

As a result, the structure can deal with a  
relatively large amount of power, and can also  
appropriately dissipate a relatively large amount of  
heat. However, in the interest of adding cooling  
25 capacity to the structure, additional heat conduction  
paths have been used. For example, with reference to  
Fig. 2, double-sided thermally conductive adhesive film  
on tape 24 is used to attach certain leads 16 to the

heat sink 12. While this structure has some advantages, the adhesive tape 24 has poor thermal conduction characteristics, and is also relatively expensive.

5        In Fig. 3, certain leads 16 are riveted directly to the heat sink 12 by means of rivets 26, providing leads 16 as additional paths for the dissipation of die heat to the printed circuit board 22. This device, however, provides a high level of interfacial  
10 resistance between the leads 16 and heat sink 12. Also, this approach is expensive and has reliability problems.

#### SUMMARY OF THE INVENTION

15        In accordance with the present invention, a surface mount package includes a unitary combination heat sink and lead frame, the heat sink having mounted thereon a semiconductor die and being mounted to a printed circuit board. The heat sink and certain leads  
20 of the lead frame provide heat conduction paths from the die to the printed circuit board, for highly effective dissipation of heat.

#### BRIEF DESCRIPTION OF THE DRAWINGS

25        Figs. 1, 2 and 3 are cross sectional views showing prior art devices;

Fig. 4 is a plan view of the present inventive unitary heat sink-lead frame structure;

Fig. 5 is a cross-sectional view of the inventive device; and

Fig. 6 is a cross-sectional view of the basic element used in achieving the invention of Fig. 4.

5

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to Figs. 4 and 5, shown therein is an embodiment of the present invention. As shown in Fig. 4, a unitary structure, heat sink-lead frame 30, i.e., a single piece having no separate parts, is provided as the basis thereof. The heat sink-lead frame structure 30 is shown as having 16 leads 32, including four leads 32A which extend from the heat sink 34, and 12 leads 32B which in accordance with common practice have their inner ends spaced frame and not connected to the heat sink 34 (of course, all leads of the lead frame in this form are connected by tie bars 36 as is well known, which will later be cut away, resulting in the leads 32A not being connected to the heat sink 34 in any manner).

With reference to Fig. 5, the heat sink 34 is mounted directly to a printed circuit board 38, and has mounted thereon a semiconductor die. The die 40 is connected by conducting wires 42 to the leads 32, and the extended ends of the leads 32 are soldered to the printed circuit board 38. In Fig. 5, the die 40 has ground pads 54 connected by conducting wires 42 to the leads 32A which in turn extend from the heat sink 34,

so that the leads 32A act as ground leads, meanwhile with other conducting wires connecting the die 40 and leads 32B so that those leads 32B are signal leads.

The die 40 and inner ends of the leads 32, along  
5 with the conductive wires 42, are housed in appropriate packaging material 44 (also noted in dotted line in Fig. 4), and the tie bars 36 are cut away, all as is well known, in forming the final device 46, which includes heat sink 34 and leads 32A extending therefrom  
10 as a unitary, single piece structure.

It will be seen that the heat sink 34 acts as a heat path for the die 40, as do the individual leads 32A extending from the heat sink 34.

This structure overcomes problems of the prior  
15 devices by including additional heat conduction paths which provide good thermal conductivity, meanwhile with the structure being low cost and avoiding the problems of poor thermal conduction adhesive tape, or the interfacial resistance in the riveting approach  
20 described above.

The lead frame-heat sink structure 30 can with advantage be formed by the dual gauge copper structure 48 of Fig. 6, wherein the relatively thick portion 48A which will define the heat sink 34 has a thickness X  
25 between the arrows which is 50 mils, while the portions 48B which will define the leads 32 have a thickness indicated by Y between the arrows which is 15 mils.

CLAIMS

What we claim is:

1. A structure comprising a heat sink and a lead frame, the heat sink and lead frame being a unitary  
5 structure.
2. The structure of Claim 1 wherein the lead frame comprises at least one lead.
- 10 3. The structure of Claim 1 wherein the lead frame comprises a plurality of leads.
4. The structure of Claim 1 and further comprising a semiconductor die mounted on the heat  
15 sink.
5. The structure of Claim 1 wherein the heat sink-lead frame unitary structure is copper.
- 20 6. The structure of Claim 1 wherein the heat sink-lead frame unitary structure is a dual-gauge element.
7. A device comprising a heat sink and a lead  
25 extending therefrom, the heat sink and lead being a unitary structure.

8. The device of Claim 7 and further comprising  
a die mounted on the heat sink.

9. The device of Claim 8 and further comprising  
5 a conductive connector connecting the die and lead.

10. The device of Claim 9 and further comprising  
a printed circuit board on which the heat sink is  
mounted.

10

11. The device of Claim 10 and further comprising  
an encapsulating member on the die and from which the  
lead extends.

12. The device of Claim 7 wherein the heat sink-  
15 lead unitary structure is copper.

13. The device of Claim 7 wherein the heat sink-  
lead unitary structure is a dual-gauge element.

20



**AMENDED CLAIMS**

[received by the International Bureau on 10 April 1998 (10.04.98);  
original claims 1-13 replaced by amended claims 1-7 (2 pages)]

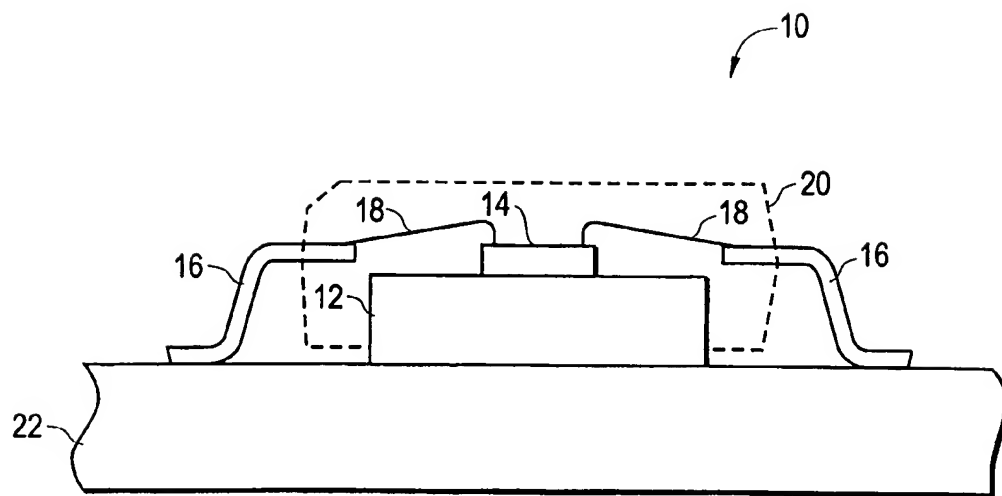
1. A structure comprising a semiconductor die,  
heat sink and a lead frame,  
5 said lead frame comprising a plurality of  
thermally and electrically conductive leads, at  
least two of said leads being thermally connected  
to said heat sink and electrically connected to  
said semiconductor die,  
10 the other's of said plurality of conductive  
leads being only electrically connected to said  
semiconductor die,  
the heat sink and the lead frame, including  
all of said leads, being a unitary structure.  
15
2. The structure of Claim 1 wherein the heat  
sink-lead frame unitary structure is copper.
3. The structure of Claim 1 wherein the heat  
20 sink-lead frame unitary structure is a dual-gauge  
element.
4. The device of Claim 1 and further comprising  
a printed circuit board on which the heat sink is  
25 mounted.

5. The device of Claim 1 and further comprising an encapsulating member on the die and from which said leads extend.

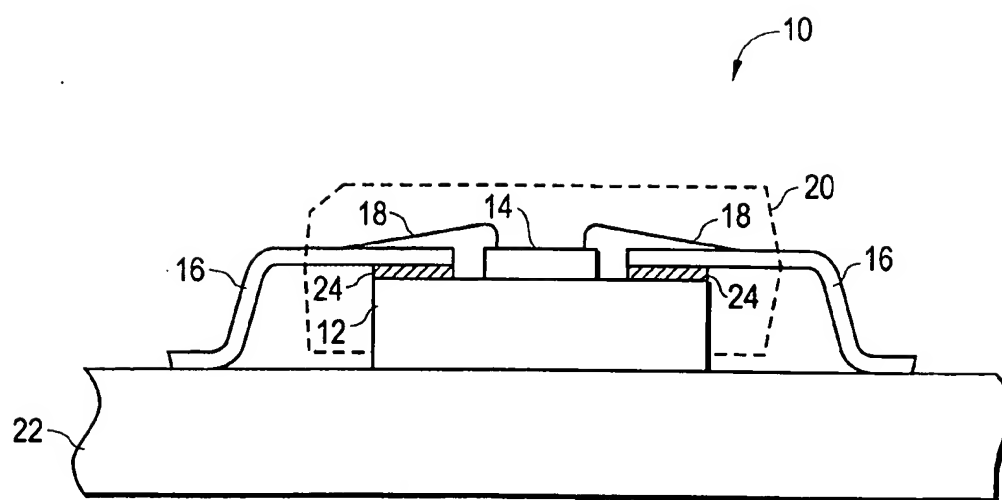
5        6. The device of Claim 4 wherein the heat sink-lead unitary structure is copper.

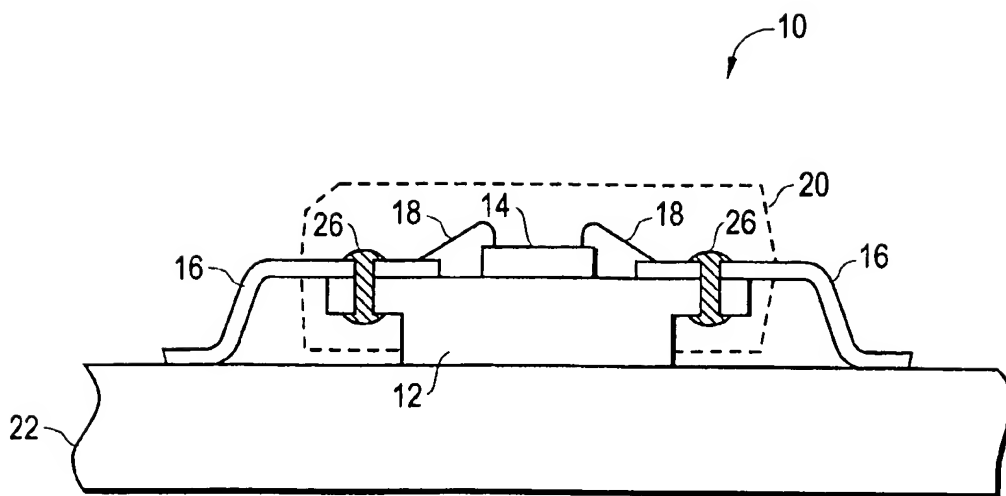
7. The device of Claim 4 wherein the heat sink-lead unitary structure is a dual-gauge element.

10

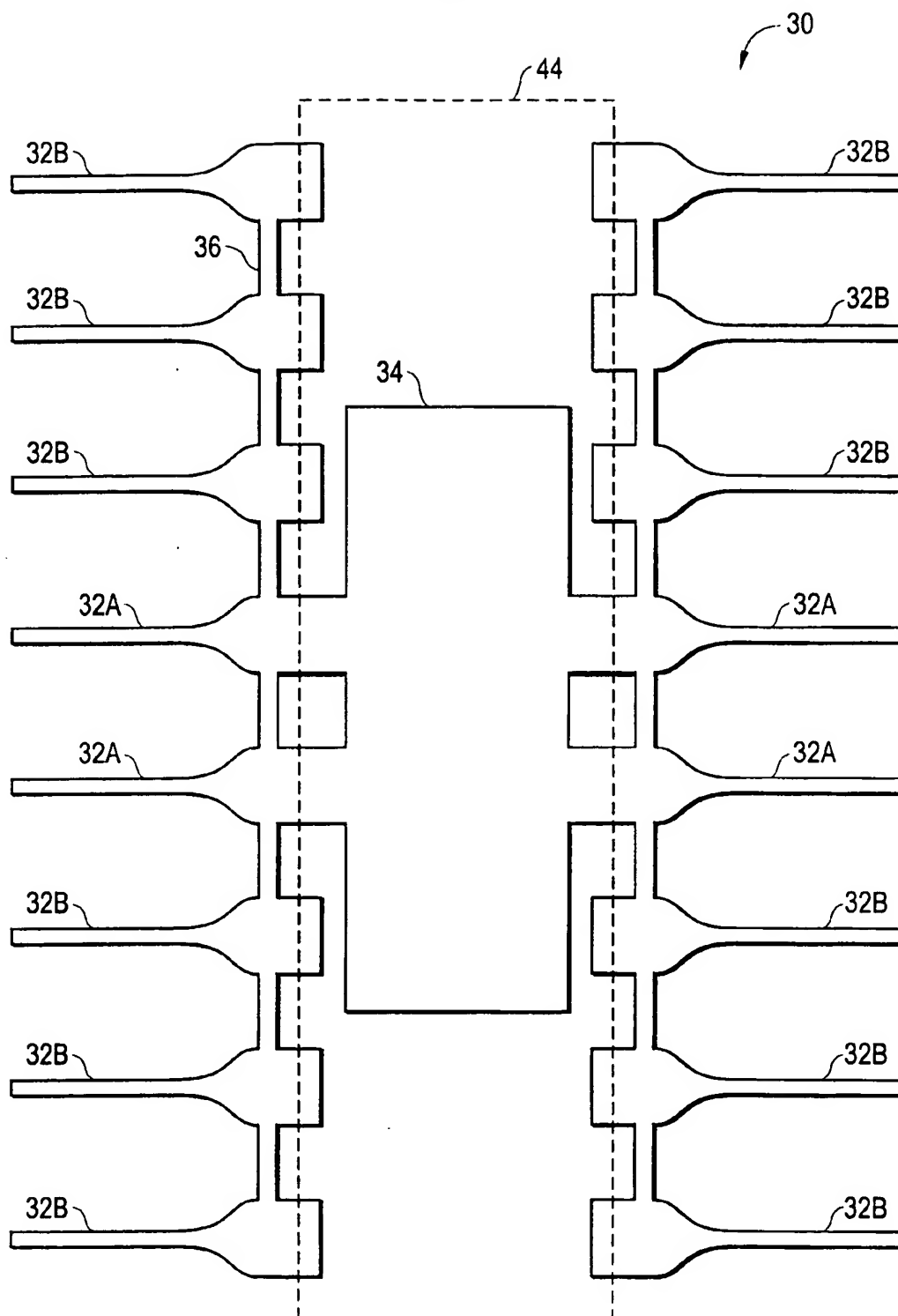


**FIG. 1** (PRIOR ART)

**FIG. 2** (PRIOR ART)

**FIG.3** (PRIOR ART)

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**FIG. 4**

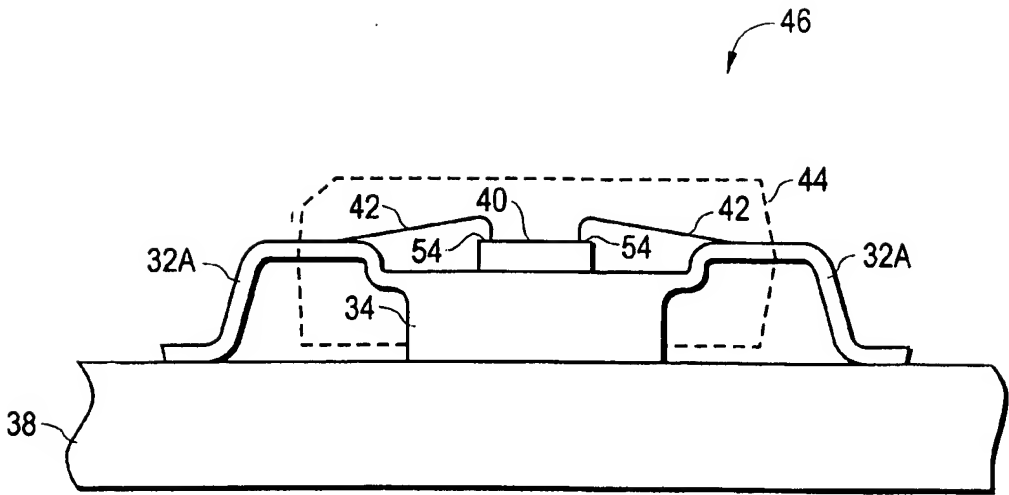
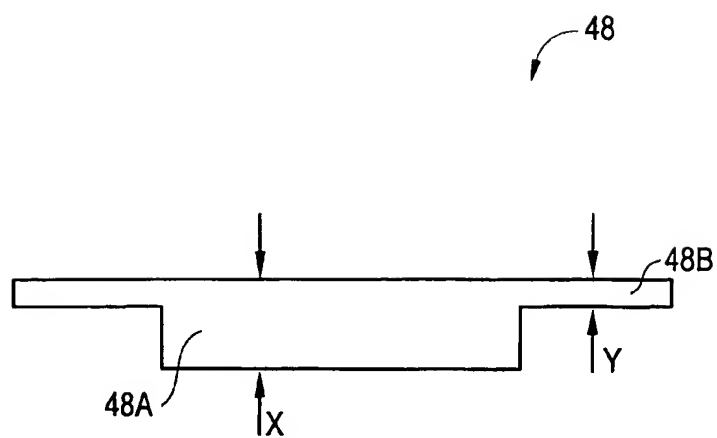


FIG.5

**FIG. 6**



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/19309

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : H05K 7/20

US CL : 361/704, 707, 709, 712; 257/706, 707

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 361/704, 707, 709, 712; 257/706, 707

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

U.S. PTO APS

search terms: heat sink, lead frame, printed circuit board

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,289,344 A (GAGNON et al) 22 February 1994 (22.02.94), col. 5, lines 42+, col. 6 line 6	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search

11 DECEMBER 1997

Date of mailing of the international search report

10 FEB 1998

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